DISTRIBUTION AND CONSERVATION STATUS OF THE STONEFLY *THAUMATOPERLA FLAVEOLA* BURNS & NEBOISS IN THE MT BULLER–STIRLING AREA

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A total of 90 sites where sampling suitable for the detection of the stonefly *Thaumatoperla flaveola* Burns & Neboiss were identified. These sites occupied an area of about 30 km by 30 km around Mt Buller, including the upper reaches of the Delatite, Howqua and King River catchments. *T. flaveola* was located at only 28 sites in an area 12 km by 10 km, almost exclusively in the upper tributaries of the Delatite River above 1000 m ASL. Surveys at sites outside this restricted area consistantly failed to locate the species, suggesting that the species has a restricted distribution based on the Mt Buller–Stirling massif.

Assigning a conservation status to the species, based on the criteria for conservation status defined by the International Union for Conservation of Nature & Natural Resources (IUCN) was relatively simple. Given the fragmented nature of the distribution, the low dispersal powers of the species and the proximity of threatening processes, the appropriate conservation status of *Thaumatoperla flaveola* is 'Endangered'.

THE stonefly family Eustheniidae (Insecta: Plecoptera) is considered to be of high scientific interest as it is believed to be the most archaic and least evolved group of stoneflies. Zwick (1979) quoted Tillyard (1921) as concluding that 'though existing today, they represent the original archtypic family of the Order, from which all other types must have been derived'. The subfamily Eustheniidae (comprising *Thaumatoperla* Tillyard and *Eusthenia* Gray in Australia) is found in Tasmania and the mainland, but 'does not extend far to the north on the mainland' and the two genera 'probably are ancient relics in Australia' (Zwick 1979).

Four species of *Thaumatoperla* (*T. flaveola* Burns & Neboiss, *T. alpina* Burns & Neboiss, *T. robusta* Tillyard and *T. timmsi* Zwick) are recognised from Australia, all from the Victorian high country. The four species are believed to have disjunct (allopatric) and relatively restricted distributions. *T. alpina* has previously been recorded only from streams on Mt Mackay, Mt Fainter and the Bogong High Plains, *T. timmsi* has only been found at a single location near Lake Tarli Karn and, prior to this study, *T. flaveola* has previously only been known from a few locations on Mt Stirling and Mt Buller. *T. robusta* has the widest known distribution, collected from isolated mountains from Mt Donna Buang to Mt Baw Baw.

Like many invertebrates associated with aquatic habitats, *Thaumatoperla* species have an aquatic larval stage restricted to freshwater systems. Most of the life cycle (up to a number of years) is passed as the immature freshwater stage. The terrestrial winged adult stage emerges from the stream following a final moult and is short lived (from a few days to a few months), but has extremely restricted powers of flight and dispersal (Pettigrove 1991).

As a result of the perceived limited distribution of each of the species, all four of the *Thaumatoperla* species are listed as threatened in Victoria, with *T. flaveola* listed as Vulnerable (CNR 1995). Two of the species (*T. flaveola* and *T. alpina*) are listed under Schedule 2 of the *Flora & Fauna Guarantee Act* 1988, requiring the Victorian Government to produce Action Statements outlining management measures to ensure their survival.

Because of the concerns about the potential impact of current and proposed alpine resort development and forestry and grazing activities in the Mt Stirling area on *Thaumatoperla flaveola*, all development in the area must take into account protection of streams for this species. Special forestry prescriptions are in force in the area, including wider than normal buffer strips left around the streams to prevent siltation.

Surveys for the species have been conducted sporadically over the past 10 years (eg. Pettigrove 1991). This paper summarises the results of those surveys, adding the results of a previously unpublished survey conducted by the Department of Natural Resources & Environment (NRE) in January 1994–April 1995, to conclusively determine the distribution and conservation status of the species.

SURVEY SITES

The Mt Buller–Stirling massif is drained by three major river systems; the wet-flowing Delatite and Howqua Rivers (both tributaries of the Goulburn River) and the north-flowing King River (which flows into the Ovens River at Wangarratta).

Historical data from 20 sites where *Thaumatoperla flaveola* were located was obtained from the Wildlife Atlas database held by the Flora & Fauna Branch of the NRE. An additional 31 sites where sampling suitable for *T. flaveola* was conducted were identified from published (Pettigrove 1991) and unpublished reports on original surveys (where full survey site data were included).

For the 1994–95 survey, 30 sites in all three catchments were selected from maps and local knowledge, based mainly on available access to streams. Where possible, a number of sites with a range of altitudes were located in each catchment and subcatchment. A number of these sites (6) were at locations where previous surveys had been conducted, meaning that data from a total of 75 sites were available from all sources.

SURVEY METHODS (1994–95)

For the surveys conducted during January 1994–April 1995, a total of one person hour was spent searching for *Thaumatoperla* nymphs at each site. This involved the collection of both kick samples which were placed in white trays and searched by hand, and by physically picking up likely habitat elements (stones and wood) and examining them by eye for larger specimens. Surrounding vegetation was also searched for adults (although none were found).

It is recognised that the species has been located buried quite deep in the bed of the stream, but no attempt was made to sample this hyporheic habitat. As the aim was to determine the distribution of the species, it was decided that a rapid wide ranging survey was more appropriate. The technique employed has been successful in determining the distribution of another large threatened eustheniid stonefly (*Eusthenia nothofagi*) in the Otway Ranges (Doeg & Reed 1995) and successfully located *T. flaveola* at sites where it had previously been recorded.

IDENTIFICATION OF SPECIMENS

While it is possible to identify eustheniid stoneflies to the generic level in the field (ie. to distinguish between *Thaumatoperla* and *Eusthenia* individuals), there are no satisfactory characteristics by which the nymphs of each of the *Thaumatoperla* species can be distinguished.

Therefore, it can only be assumed that all individuals of *Thaumatoperla* collected and identified within the study area were, in fact, *T. flaveola*. This is based on the observation of Zwick (1979: 24) that 'as the species are allopatric, assignment of larvae to particular species is usually no problem'. Also, no adults of any other *Thaumatoperla* species have been collected from the Mt Buller–Stirling area during any previous survey.

RESULTS

From the 75 sites where data are available, *Thaumatoperla* nymphs have been located at 28 sites in the Mt Buller–Stirling area (Fig. 1). The majority of sites (18 sites) where the species was recorded lie within the upper Delatite River basin. There are relatively few sites (7 sites) within the upper Delatite River where the species has not been recorded at some time.

A further 6 sites were located in the upper tributaries of the Howqua River and 4 sites in the upper tributaries of the King River. These sites were invariably in the very uppermost tributaries draining just over the ridgeline from the Delatite basin. This is particularly evident at sites on the King River tributaries (top of Fig. 1), where the species was absent from numerous sites further downstream.

While many sites were sampled outside this area (25 sites are not shown in Fig. 1), no specimens of *Thaumatoperla* were recorded. The sites not shown included many on the opposite ridge on the Howqua River (around Rocky Knob) and surrounding catchments (Macalister, Wonnangatta, Buffalo and Dandongadale Rivers), mostly within 20–30 km of Mt Buller.

Assuming that all *Thaumatoperla* specimens collected were *T. flaveola*, it can therefore be stated with some certainty that the species is restricted to a small geographic area around Mt Buller, Mt Stirling and Mt Winstanley, either side of the ridgeline surrounding the headwaters of the Delatite River. The lowest altitude that the species was recorded at is 1100 m. As such, the area included in the distribution is approximately 12 km measured from east to west and 10 km north to south.

DISCUSSION

Distribution of Thaumatoperla flaveola

Accurately defining the distribution of any invertebrate species is difficult, especially if relying on historical information (eg. Wildlife Atlas data). In the main, historical data only includes sites where a particular species has been located, giving no information on areas where suitable searches have been conducted without locating the target

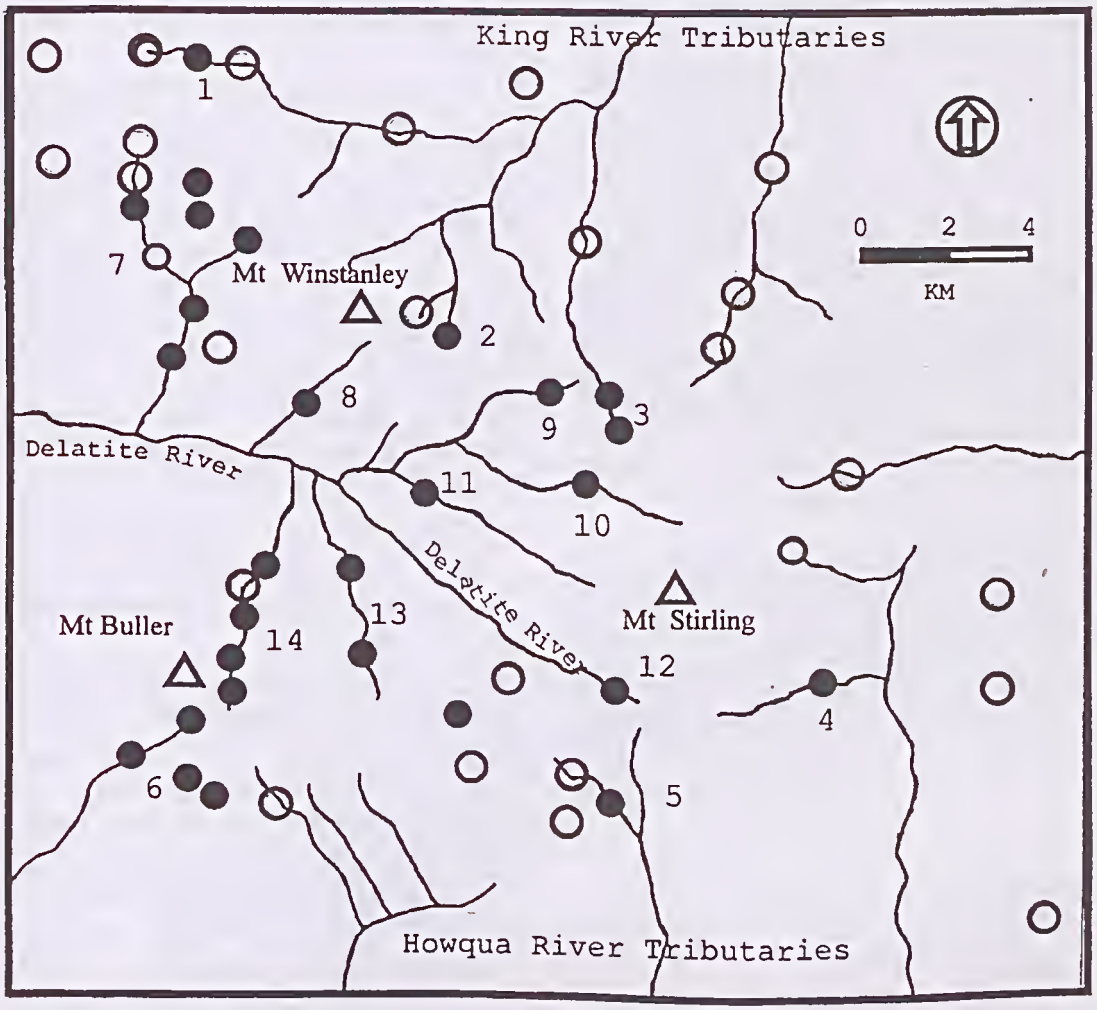

Fig. 1. Map of the Mt Buller–Mt Stirling area showing the location of sites where *Thaumatoperla flaveola* have been recorded (●) and not recorded despite suitable sampling (O). A further 25 sites where the species were not recorded are off the area of the map. Numbers refer to discrete locations discussed in the text.

species. Hence, while a distribution may be defined on the presence of the species, there are often no data to show the species to be absent outside this area.

This can result in misleading conclusions as to the true distribution of some species. For example, works like the Zoological Catalogue (eg. Commonwealth of Australia 1988) list many invertebrate species that have only been located at the type locality. Many other taxonomic works also only list a few sites where a species has been found. These suggest that the species have extremely limited distributions, which may not be true.

In this case, specific surveys and the interpretation of original data sets has allowed an accurate definition of the distribution of *Thaumatoperla flaveola* in the Mt Buller–Stirling area. The species was consistently recorded in a small area around Mt Buller, Mt Stirling and Mt Winstanley, in an area 12 km by 10 km. Searching at a large number of sites outside this area consistently failed to find the species. Rather than the sites where the species was located, it is the density of sites searched outside the known distribution, and the consistent failure to locate the species, that provides adequate evidence to delineate the true distribution.

The species has been recorded in a variety of stream types, ranging from small, almost dry tributaries to larger fast flowing streams. However, there are certain sites with comparatively high abundances, as occasionally noted during 1994–95 and other surveys. The most obvious such sites have been located in two tributaries of Currajong Creek and in Brown Creek (sites 7 and 8 in Fig. 1).

These sites had similar morphologies, where the stream was composed of a series of terraces, separated by steep sections. The flow was low and mainly percolated through the open stream bed. It may well be proven that these are the preferred habitats of the species, as fewer individuals have been located at sites with different morphologies. Further work needs to be done on the ecological requirements of the species before a preferred habitat or stream type can be positively identified.

Conservation status of Thaumatoperla flaveola

Data such as these should allow a more accurate evaluation of the conservation status of the species, based recently on IUCN categories (IUCN 1994). The categories are based on: an observed population reduction (Criterion A); a reduced area of occupancy or extent of occurrence (Criterion B); population abundance (Criterion C); or probability of extinction (Criterion D). There are no quantitative measures of population reduction, abundance or probability of extinction for *T. flaveola*, but the extent of occurrence is known (about 120 km^2). The limit for Critically Endangered is an extent of occurrence less than 100 km^2, so that category is not appropriate, but Endangered (extent of occurrence less than 5000 km^2) or Vulnerable (less than 20 000 km^2) are both appropriate. For one of these conservation categories to be assigned based on Criterion B, information on at least two of the following are required:

- the number and fragmentation of locations;
- decline in abundance or extent of occurrence; or
- fluctuations in abundance or extent of occurrence.

While there is no evidence of fluctuations in extent or abundance, it can be inferred that the known extent has declined. There is a record in the Wildlife Atlas at Mt Timbertop (8 km to the west of Mt Buller), collected in the late 1950s by Neboiss. Searching during 1994–95 around Mt Timbertop, and between Mt Timbertop and the closest currently known location, has consistently failed to confirm the presence of the species in this area. Either the original record is incorrect, or the species has disappeared from the general location (for some unknown reason).

Hence, the determination of conservation status is dependant on the number of subpopulations and the fragmentation of the population, which can be:

- Severely fragmented *or* known to exist at no more than 5 locations (Endangered); or
- Severely fragmented *or* known to exist at no more than 10 locations (Vulnerable). (*Note:* author's emphasis.)

The extent of fragmentation and the number of locations for aquatic stream-dwelling invertebrates is often difficult to determine. A 'location' is defined as 'a geographically or ecologically distinct area in which a single event (eg. pollution) will soon affect all individuals of the taxon present. A location usually, but not always, contains all or part of a subpopulation of the taxon, and is typically a small proportion of the taxon's total distribution' (IUCN 1994). 'Severely Fragmented' is defined as 'the situation where increased extinction risks to the taxon results from the fact that most individuals within a taxon are found in small and relatively isolated subpopulations. These small subpopulations may go extinct, with a reduced probability of recolonisation' (IUCN 1994).

The number of locations for the species based on the definition, is unclear. It could be argued that there are three distinct locations—the Delatite River, the King River and the Howqua River as geographically distinct areas—clearly making the species 'Endangered' under the IUCN classification. However, it is unlikely that a single event would affect all the individuals in one of these areas (with the exception perhaps of a widespread fire). A single event would be more likely to affect all individuals within a linear subcatchment, so it could also be argued from Fig. 1 that there are three locations within the King River catchment (numbered 1–3: see Table 1), three locations in the Howqua River catchment (4–6) and possibly eight locations within the Delatite River catchment (7–14)—giving a total of 14 locations.

This scenario places the species just outside the range for 'Vulnerable' (less than 10 locations) and suggests the appropriate IUCN classification would be 'Lower Risk Conservation Dependant' (defined as taxa which do 'not satisfy the criteria for any of the criteria Critically Endangered, Endangered and Vulnerable' but which are 'the focus for a continuing taxon specific or habitat specific conservation programme ..., the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years') or 'Lower Risk Near Threatened' (defined as taxa which do 'not quality for Conservation dependant, but which are close to qualifying for Vulnerable').

However, the criteria call for an evaluation of the number of locations or the degree of fragmentation. *Thaumatoperla flaveola* clearly has a fragmented distribution under the definition. Given that the species is restricted to the upper parts of each catchment, the chance of one of the locations becoming extinct is high. The Mt Buller–Stirling area is subject to a number of activities which could be detrimental to the species. Mt Buller is subject to significant alpine resort development and activities. Less so Mt Stirling and the Razorback Spur area, but both timber harvesting and grazing are common there. Grazing can severely disturb the upper spring and seep areas of streams, resulting in the disappearance of at least one species (*Spathula tryssa*) from grazed spring heads (R. St. Clair, EPA, unpublished data). This would indicate that none of the populations are completely free from potential disturbance and extinction.

Given the low dispersal power of the adults, there would be little chance of recolonisation between sites in different subcatchments, should one of them go extinct. This would be especially true at those sites outside the Delatite River catchment (ie. those in the King River and Howqua River catchments), where flying adults would be the only reasonable means of colonisation. Within the Delatite basin, there is a chance that recolonisation between subcatchments could occur through movement of the larvae along the stream lines, but even this would be relatively unlikely, given the distance between the sites.

Taken together, proximity of potentially threatening processes, the fragmented nature of the distribution, the observed reduction in extent of occurrence and the small total extent of occurrence (120 km^2), the appropriate conservation status of the species under the guidelines of the IUCN would appear to be 'Endangered'.

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Number	Catchment	Creek name	Number	Catchment	Creek Name
1	King	Mine Ck	8	Delatite	Brown Ck
2	King	Fork Ck	9	Delatite	Falls Ck
3	King	unnamed	10	Delatite	Baldy Ck
4	Howqua	Stanley Ck	11	Delatite	Bluff Ck
5	Howqua	unnamed	12	Delatite	Delatite R.
6	Howqua	South Buller Ck	13	Delatite	Chalet Ck
7	Delatite	Currajong Ck	14	Delatite	Boggy Ck

Table 1. Creek names of the 14 possible 'locations' for *Thaumatoperla flaveola* as noted in Fig. 1.

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